ings of the last two sketches may be due to contrast with the very brilliant border of the planet. The shadings of 1889, June 3d, may be due to the same cause. Those of May 29th, are probably real, and may serve to compare with other drawings for the determination of the rotation-time.

THE COMPANION OF *SIRIUS*, AND ITS BRIGHTNESS ACCORDING TO PHOTOMETRIC THEORY.

By William J. Hussey.

The companion of *Sirius* was last observed by Professor Burnham in April, 1890, with the thirty-six-inch telescope of the Lick Observatory. In October, November, and December of that year, and in October of the following year, he examined *Sirius* on five nights under good conditions, but was unable to see the companion. At that time the companion was within 4″.2 of its primary, and the distance was decreasing. Since then, according to the elements that have been computed, it has passed its minimum distance, and at the beginning of this year (1896) was at about the same distance as when last observed in 1890. This being the case, it was expected that the companion could be observed again in the early part of this year. I have looked for it with the thirty-six-inch telescope as follows:

1896, February 9.—Examined *Sirius* carefully when near the meridian, using various powers, from 350 to 1900. Seeing good. Companion not seen.

February 14.—Seeing good. Companion not seen.

February 19.—Examined *Sirius* with powers 270, 1900, and 2600. The micrometer wire was set to the ephemeris place of the companion, and the entire region thereabouts examined carefully. Seeing good. Companion not seen.

March 11.—Examined *Sirius* with powers 350, 550, 1000, 1900, and 2600. Each eye-piece was provided with a diaphragm, accurately at its focus, covering half the field of view. By this means *Sirius* could be placed out of view, and the region close about it still examined. Seeing very good. Companion not seen.

March 12.—Examined *Sirius* with powers 350, 1000, 1500, 1900, and 2600. Eye-pieces were provided with diaphragms, as

before. Searched carefully from position-angle 90° to 270°, and at varying distances. Seeing good. Companion not seen.

All the observations were made when *Sirius* was near the meridian. Color screens of various shades were tried each night.

On the nights of March 11th and 12th, Professor CAMPBELL also looked for the companion, using various powers. Eyepieces provided with diaphragms. Color screens tried. The companion was not seen. On the last date he also examined the ephemeris region spectroscopically, with a slit sufficiently narrow to exclude most of the light of *Sirius*. The spectrum of the companion was not seen.

The companion of *Sirius* was first known by the disturbances it produced in the motion of *Sirius*. This was shown by BESSEL'S investigations in 1844. It was discovered visually early in 1862, and between that time and the date of the last observation in 1890 it described about 85° of position-angle. This arc is not sufficient to enable a certain determination of the elements of the orbit to be made. The various systems of elements that have already been computed differ considerably among themselves. For example: the periodic time according to AUWERS' elaborate investigation is 49.399 years (*Astr. Nach.*, Nos. 3084–85); according to HOWARD'S graphical construction, 57.02 years (*Astr. Journal*, No. 235); and according to GORE'S determination, 58.47 years (*Monthly Notices*, June, 1889). The other elements vary similarly.

With the parallax of *Sirius* as determined by GILL and ELKIN, 0″.38, AUWERS has found—

Mass of *Sirius* = 2.20
Mass of companion = 1.04

the mass of the Sun being taken as unity. From this it appears that the mass of the companion is nearly half that of *Sirius* itself. That some such relation between the masses should exist was pointed out by Professor SAFFORD in 1863,* before it had become certain that the companion was the body indicated by theory; and more accurately by M. O. STRUVE in 1866, who wrote† as follows:

"Admitting that the observed satellite is identical with BESSEL'S obscure body, its mass must be estimated approximately half that of *Sirius* itself. If both bodies had the same physical

* *Proceedings of the American Academy of Arts and Sciences*, Vol. VI.
† *Monthly Notices*, Vol. 26, p. 270.

constitution, this relation of the masses would assign to the globe of the satellite a diameter only 1.26 times smaller than that of the principal body, and, therefore, considering the extraordinary brightness of the large star, we should be induced to place also the satellite in the class of first magnitude. With this conclusion, the observed brightness of the companion forms a manifest contradiction. It is commonly said to be of the ninth or tenth magnitude; and only in the spring of 1864 I have noted it once as of the eighth magnitude, probably on account of the extraordinary favorable state of the atmosphere. Hence, it follows that, to maintain the identity, we must admit that both bodies are of a very different physical constitution. That the light of the satellite is increasing, as I was inclined to suppose from the comparison of my observations of 1864 with those of 1863, has not been confirmed by later observations; but in our latitude* the estimation of the brightness depends too much on the condition of the atmosphere to admit of an accurate judgment in this respect."

According to AUWERS' investigation, the mean distance of the companion from *Sirius* is 19.92 astronomical units, or, approximately, the distance of *Uranus* from the Sun. It is doubtful whether a planet at that distance from its primary, and at the distance of *Sirius* from the Earth, would be visible if shining by reflected light alone. It is not without interest, however, to know what would be the variations of brightness of a planet so situated. I have, therefore, computed the brightness of the companion on this hypothesis, and give the results in the accompanying table. The brightness at the time of visual discovery has been taken as unity, and the results are given through one complete revolution. HOWARD'S elements have been used as the basis of the calculation.

In the case of a double star, the inclination as given does not uniquely determine the position of the plane of the orbit, but simply indicates two positions, one of which is the correct one. On this account, there are two cases to be considered. The values for both positions have been computed, and are given under the headings I and II, respectively.

Two sets of values for each position are given. One has been computed by EULER'S and the other by SEELIGER'S photo-

* The latitude of Pulkowa is 59° 46′. The declination of *Sirius* is — 16° 34′. The meridian zenith distance of *Sirius* at Pulkowa is, therefore, 76° 20′.

metric formula. In accordance with EULER'S theory, the brightness varies as

$$\frac{\cos^2 \frac{1}{2} \alpha}{r^2},$$

and with SEELIGER'S theory as

$$\frac{1 - \sin \frac{1}{2} \alpha \tan \frac{1}{2} \alpha \log_e \cot \frac{1}{4} \alpha}{r^2},$$

where r is the distance of the companion from *Sirius* and α the phase-angle, or angle at the companion between *Sirius* and the Earth.

MT. HAMILTON, CAL., May 25, 1896.

BRIGHTNESS OF THE COMPANION OF *SIRIUS* IN TERMS OF ITS BRIGHTNESS AT DISCOVERY.

DATE.	EULER'S THEORY.		SEELIGER'S THEORY.		REMARKS.
	I.	II.	I.	II.	
1862.2	1.00	1.00	1.00	1.00	Discovery.
64.0	1.08	0.96	1.08	0.95	
66.0	1.18	0.94	1.19	0.92	
68.0	1.32	0.92	1.35	0.89	
1870.0	1.49	0.92	1.52	0.88	
72.0	1.70	0.92	1.75	0.87	
74.0	1.99	0.93	2.05	0.87	
76.0	2.37	0.96	2.47	0.88	
78.0	2.89	1.01	3.04	0.91	
1880.0	3.62	1.05	3.87	0.95	
82.0	4.73	1.11	5.11	0.98	
84.0	6.46	1.20	7.12	1.04	
86.0	9.39	1.29	10.60	1.09	
88.0	14.70	1.35	17.18	1.12	
1890.0	24.74	1.29	30.52	1.05	
90.27	26.91	1.27	33.21	1.03	Last observation.
92.0	42.51	1.14	54.73	0.91	
94.0	50.39	2.47	59.26	2.00	
96.0	27.65	4.97	30.52	4.31	
98.0	10.65	4.81	11.03	4.50	
1900.0	4.53	3.77	4.50	3.71	
2.0	2.60	2.93	2.41	2.98	
4.0	1.51	2.33	1.50	2.41	
6.0	1.14	1.94	1.13	2.01	
8.0	0.96	1.65	0.95	1.71	
1910.0	0.89	1.45	0.88	1.50	
12.0	0.82	1.30	0.81	1.35	
14.0	0.89	1.18	0.87	1.21	
16.0	0.90	1.10	0.89	1.11	
18.0	0.96	1.03	0.96	1.01	
1920.0	1.03	0.98	1.03	0.98	